ALLAYING COAL DUST DURING OPERATION OF CONTINUOUS-MINING MACHINES IN UTAH

By W. M. Merritts and Thomas T. Reay, Jr.

* * * * * * * * * * Information Circular 7608

UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary
BUREAU OF MINES
James Boyd, Director

Work on manuscript completed March 1951. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Information Circular 7608."

June 1951

Generated on 2024-09-20 07:01 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

ALLAYING COAL DUST DURING OPERATION OF CONTINUOUS-MINING MACHINES IN UTAH

by

W. M. Merritts[1/] and Thomas T. Reay, Jr.[2/]

CONTENTS

	Page
Introduction and summary	1
Acknowledgment	1
General information	2
Continuous miner	3
The coal-dust hazard	3
Spraying during cutting and loading	3
Equipment used in allaying coal dust	4
Type of pumps	5
Type of nozzles	5
The wetting compound	5
Arrangement of spray nozzles of various sizes of orifices on continuous-mining machine	6
Method of adding wetting compound	6
Dust conditions during original test	6
Method adopted in Sunnyside No. 2 mine	7
Survey of air-borne dust	7
Description and operation of midget impinger	7
Data relating to operation of the continuous-mining machine in Sunnyside No. 1 mine	7
Dustiness limits	8
Density of dust samples	8
Number concentration of mine atmospheric dust determined by the midget microprojector method	9
Size of dust particles	9
Rate of discharge of pump	9
Type and dimensional position of spray nozzles installed on continuous-mining machine	10
Nozzles	11

1/ Mining engineer (Coal), Bureau of Mines, Salt Lake City, Utah.
2/ Coal-Mine inspector, Bureau of Mines, Salt Lake City, Utah.

Information Circular 7608

Generated on 2024-09-20 07:03 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

TABLES

		Page
1.	Designated positions, manufacturer's numbers, and orifice diameters of spray nozzles used during original dust-allaying test of continuous-mining machine equipped with additional nozzles.....	5
2.	Density of air-borne dust samples collected during operation of the continuous-mining machine.....	9
3.	Quantity of water discharged by a pump through high-pressure spray nozzles at various pressures.....	10

ILLUSTRATIONS

Fig.		Follows page
1.	Schematic sketch of effective arrangement of spray nozzles on continuous-mining machine at Sunnyside No. 1 mine, Utah Fuel Co., Sunnyside, Utah.....	4
2.	High-pressure spray nozzles mounted at positions B and A, respectively, on continuous-mining machine, and cutter-chain bit blocks on machine.....	4
3.	Steel receptacle in which wetting-compound cartridges were placed.....	6
4.	Complete operating assembly of the high-pressure triplex plunger pump except for the wetting-compound receptacle.....	6
5.	Plan showing position of continuous-mining machine, arrangement of line brattice, and three places where dust samples were collected in No. 23 crosscut and 8 left entry, 2 dip, Sunnyside No. 1 mine, Kaiser Steel Corp., Sunnyside, Utah.....	6
6.	Side and end sectional view of high-pressure spray nozzle.....	10
7.	Complete assembly of two high-pressure spray nozzles	10
8.	Sectional drawing of atomizer spray nozzle.....	10

Generated on 2024-09-20 07:04 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

INTRODUCTION AND SUMMARY

The control of coal dust created and released during the operation of continuous-mining machines in bituminous-coal mines of the United States is a problem. The interest manifested in this problem indicates the seriousness of the hazards involved, particularly when the dust has not been abated at its source and has become air-borne.

Officials of the Sunnyside No. 1 mine, Kaiser Steel Corp., were confronted with the problem of abating the coal dust created by operation of a recently installed continuous-mining machine, and they requested the aid of representatives of the Coal-Mine Inspection Branch, Bureau of Mines, United States Department of the Interior, in developing an effective method of allaying the coal dust at its source.

As a result of observations made and of dust counts obtained during this survey with and without the use of water and of water mixed with a wetting agent, the following conclusions are drawn:

1. Dust can be allayed satisfactorily by the use of water sprays on the continuous-mining machine, if it is properly installed.

2. The use of wetting agents materially improves the allaying of dust.

3. Efficiency and safe operation of the machine are increased because of better visibility when dust is allayed.

4. Respirators are no longer required when dust is allayed.

The perfected method of allaying the coal dust created by continuous mining machines in Sunnyside Nos. 1 and 2 mines satisfied the recommendations of the Federal Mine Safety Code for Bituminous and Lignite Mines of the United States, relating to the control of coal dust and a district coal-mine inspector of the Industrial Commission of Utah considered that the installation met the requirements of the Utah General Coal Mine Safety Orders.

ACKNOWLEDGMENT

The writers acknowledge with thanks the cooperation of R. G. Heers, manager of Sunnyside operations; W. B. Odendahl, formerly general superintendent, Sunnyside No. 1 mine; G. A. Farnsworth, mine superintendent, Sunnyside No. 1 mine; Clifford Powell, formerly mine foreman, Sunnyside No. 1 mine, and Mike Manzanares, machine operator, Sunnyside No. 1 mine; James Phillips, district coal-mine inspector of the Safety Division, Industrial Commission of Utah; Thomas McCourt, general mine superintendent, and Lee Alger, master mechanic, Sunnyside operations, for the valuable assistance and constructive criticism

Generated on 2024-09-20 07:05 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

given while making the study on allaying the coal dust created by the continuous-mining machines; and of Donald Wiebe, assistant research engineer, Joy Manufacturing Co., Franklin, Pa., for the information and data pertaining to the design, capacities, and sizes of the different spray nozzles used on the continuous-mining machines.

GENERAL INFORMATION

The Sunnyside No. 1 mine is at Sunnyside, Carbon County, Utah, and is developed in the Lower Sunnyside coal bed, which averages 12 feet in thickness and dips about 7 degrees in a northeasterly direction. The coal is of bituminous rank, very friable, and contains an appreciable amount of resin. The maximum overburden at the face of the present working place is about 2,000 feet.

The proximate analysis of the coal is as follows:

	Percent
Moisture	9.9
Volatile matter	36.7
Fixed carbon	48.7
Ash	4.7
Total	100.0
Sulfur	1.17
B.t.u.	12,590

The ratio of volatile to total combustible, which is an index to the explosibility of coal dust, is shown by the following formula:

$$\frac{\text{Volatile matter}}{\text{Volatile matter plus fixed carbon}} = \frac{36.7}{36.7 + 48.7} = 0.43$$

The ratio of volatile to total combustible of the coal in this mine is 0.43, which indicates that the coal dust is highly explosive. Bureau of Mines tests and experiments have shown that coal dust having a ratio of volatile to total combustible exceeding 0.12 is explosive, and that the explosibility increases as the ratio increases.

The mine was developed by the room-and-pillar method and by a panel-and-entry system. Main entries were driven in pairs, slopes or dips in sets of two and four, and panel entries in sets of two, three, and four. Entries were driven 14 to 18 feet wide and rooms 26 feet wide. Pillars were being recovered by the pocket-and-skip method.

The mine is classed gassy by the Safety Division of the Industrial Commission of Utah.

Electric power (220 volts alternating current and 550 volts direct current) was used underground. The continuous-mining machine was powered by 500-volt, direct-current motors.

Generated on 2024-09-20 07:02 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

CONTINUOUS MINER

The continuous mining machine does everything that formerly was done in the separate operations of cutting, drilling, shooting, and loading out coal from underground working places. At the time of the coal-dust allaying tests, there were only two continuous-mining machines in operation in the coal mines of Utah, and these were operated in the Sunnyside Nos. 1 and 2 mines. The design of both of these machines follows the rules and regulations for permissible mining machines prescribed by the U. S. Bureau of Mines, and both machines were provided with permissible approval plates.

THE COAL-DUST HAZARD

The dust was created and released by the operation of the cutting and conveyor head of the continuous mining machine supplemented greatly by the extreme friability of the coal.

At the beginning of the study to find an effective method of allaying the coal dust created by the continuous-mining machine, the presence of air-borne dust in the working face area, and far back into the return air course, interfered with visibility to such an extent that it was impossible for the machine operators to see the working face and the cutting and conveyor head of the machine. The operator had to wear a respirator continuously while operating the machine. In addition to the explosion hazard and health-impairment hazard, there was a definite accident hazard, because the machine operator could not see the ribs, the face of the coal, the condition of the roof overhead, and the moving parts of the machinery.

The three spray nozzles mounted on the continuous-mining machine by the manufacturer of the machine did not discharge enough water or solution of water and wetting compound to allay effectively the coal dust created by operation of the machine.

SPRAYING DURING CUTTING AND LOADING

It has been accepted generally that allayment of dust by water spraying is the principal means of dealing with the problem, and much has been done to develop satisfactory equipment for this purpose.3/ It is believed that no single type of spray that can meet the requirements of all coal mines is likely to be devised;4/ consequently, work has been done to develop sprays to suit various conditions, as well as on the placement of the nozzles on the machines.

3/ Harrington, D., Forbes, J. J., Cash, F. E., Denny, E. H., Herbert, C. A., Parker, Owings, C. W., and Miller, A. U., Allaying Dust in Bituminous-Coal Mines With Water: Bureau of Mines Tech. Paper 593, 1939, 55 pp.

4/ Johnson, Leland H., Dust Problems in the Mines of the Pennsylvania Anthracite Region: Bureau of Mines, Tech. Paper 704, 1947, 34 pp.

Generated on 2024-09-20 07:03 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Size of water droplets plays an important part in the development of suitable sprays. In some coal mines best results were obtained with sprays that yielded fairly large droplets,5/ like fine rain drops; however, it will be noted in the following that water and water mixed with a wetting compound were in the form of a medium-mist spray.

EQUIPMENT USED IN ALLAYING COAL DUST

A high-pressure triplex plunger pump that created a static pressure of 800 pounds per square inch at no delivery was used to develop high hydraulic pressures to force water or solutions of water mixed with wetting compound to the continuous-mining machine at desired pressures. The pump was driven by a 5-horsepower, 500-volt, direct-current motor, and the pump and motor were assembled into a working unit by a manufacturer of mining equipment.

The pump was placed along the entry at a water sump about 300 feet from the continuous-mining machine. The water was delivered from the pump to within 50 feet of the machine through a 3/4-inch pipeline, and thence to the machine through a 3/4-inch rubber hose. The water was dispensed at the machine through seven spray nozzles, which were placed strategically and effectively on and near the cutting and conveyor head, as shown in figure 1; however, only five of the seven spray nozzles (not shown) were placed on the right side of the cutting and conveyor head of the machine in positions corresponding with C and D nozzles on the left side of the machine. For reference purposes, the positions of the two spray nozzles not shown in figure 1 are designated as F and G, corresponding to the positions of the C and D spray nozzles on the left side of the machine.

The spray nozzles designated A, B, and E were placed on the machine by the manufacturer. The positions of spray nozzles A and B on the continuous mining machine are shown on figure 2 also. Spray nozzles C, D, F, and G were placed on the machine during the study to obtain an effective method of allaying the coal dust created by the continuous-mining machine.

On other types of continuous-mining machines other spray nozzles of the type used during the tests probably would have to be placed differently so as to contact the dust at its source.

The alphabetically designated positions of the spray nozzles on the machine and the manufacturer's description follow:

5/ Jones, T. David (Prof. of Coal and Metalliferous Mining, University of Birmingham, England), Dust Abatement in Australian Collieries; Steel Industries Colliery Development. Reprint of series of articles published in June, September, and December 1947 issues of The Broken Hill Proprietary Company Limited Review, 422 Little Collins Street, Melbourne, Australia.

Generated on 2024-09-20 07:08 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-20 07:05 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

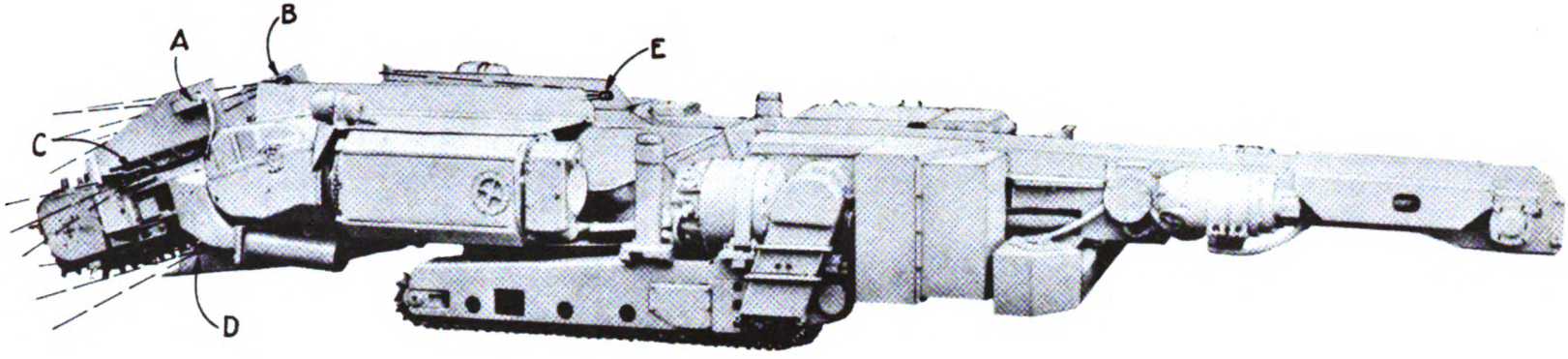

Figure 1. - Schematic sketch of effective arrangement of spray nozzles on continuous-mining machine at Sunnyside No. 1 mine, Utah Fuel Co., Sunnyside, Utah.

Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-20 07:00 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

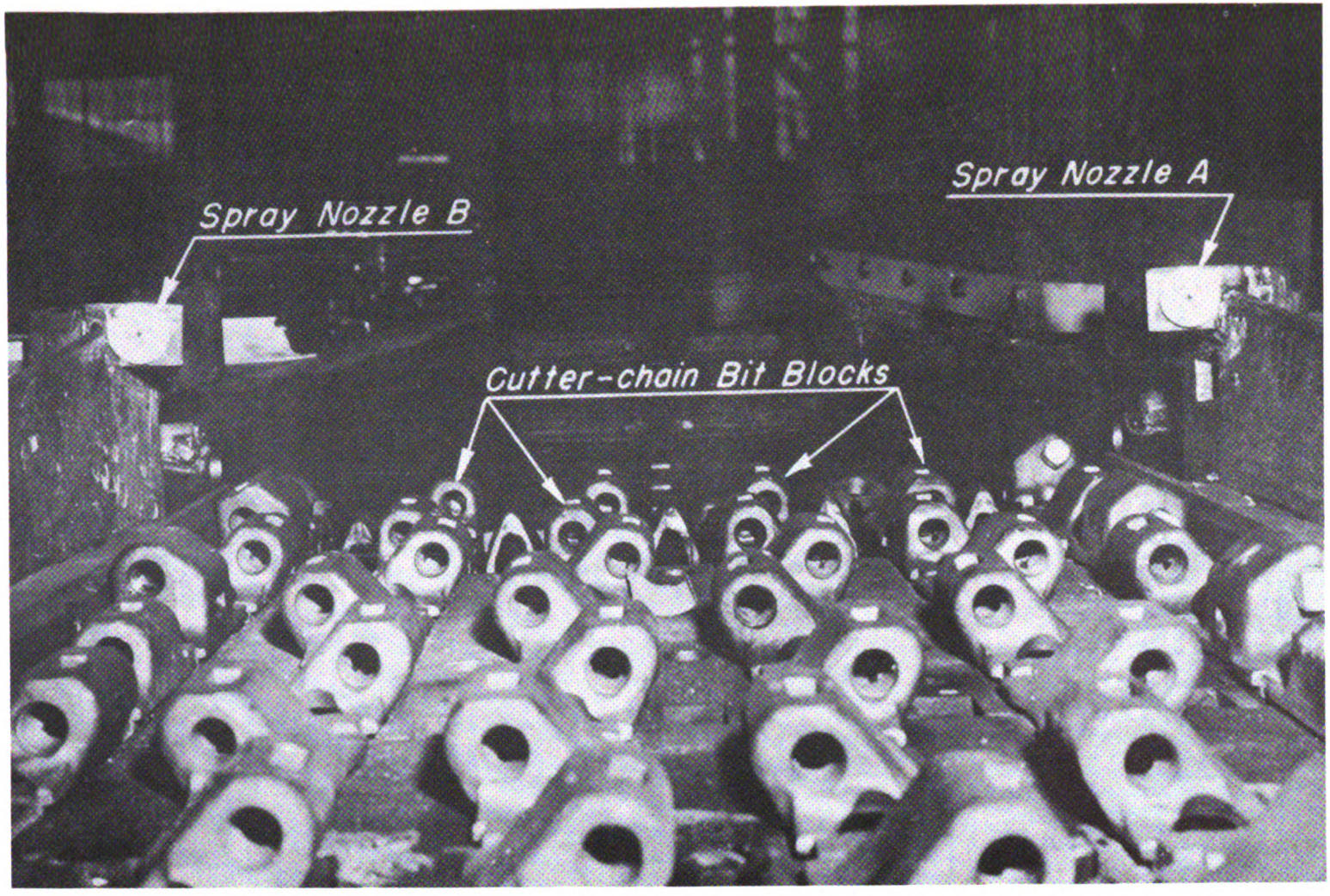

Figure 2. - High-pressure spray nozzles mounted at positions B and A, respectively, on continuous-mining machine, and cutter-chain bit blocks on machine.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

TABLE 1. - Designated positions, manufacturer's numbers, and orifice diameters of spray nozzles used during the original dust-allaying test of continuous mining machine equipped with additional nozzles

Position of spray nozzles	Manufacturer's designating numbers for the spray nozzles	Diameter of the orifices of the spray nozzles, 64ths of an inch
A.....	No. 5	5/64
B.....	No. 5	5/64
C.....	No. 5	5/64
D.....	No. 4	4/64
E.....	No. 3	3/64
F.....	No. 6	6/64
G.....	No. 4	4/64

Note: The information on the high-pressure spray nozzles was provided through the courtesy of the distributor.

When the seven spray nozzles were operated at full capacity, the pressure created by the pump decreased from 800 to 300 pounds per square inch without any apparent decrease in the effectiveness of the spray nozzles.

The effectiveness of water used alone during operation of the machine was observed to be satisfactory with the indicated arrangement of the seven spray nozzles, because the mist from the nozzles covered all outlets of coal dust from the machine. When a wetting compound was used with water, the results indicated beyond a doubt that virtually all particles of coal dust were agglomerated or flocculated and settled to the floor at the cutting and conveyor head. Water alone was used only experimentally to allay the coal dust created by the continuous-mining machine. Water mixed with a wetting compound was used exclusively, except during some of the tests conducted for experimental purposes.

TYPE OF PUMPS

The two high-pressure, triplex-plunger pumps used in the Sunnyside Nos. 1 and 2 mines to create pressures to force water and solutions of water mixed with the wetting compound to and through the spray nozzles on the two continuous-mining machines were positive-displacement pumps operated at fairly constant speeds and delivered about 12.8 gallons a minute at a pressure of 300 pounds a square inch. The pumps were the permissible type approved by the Bureau of Mines. The two pumps were electric-motor driven units a type approved by the U. S. Bureau of Mines.

TYPE OF NOZZLES

The nozzles were high-pressure spray nozzles.

THE WETTING COMPOUND

The wetting compound, which is a balance blend of wetting and dispersion chemicals, is a chemical concentrate that, when added in minute quantities

Generated on 2024-09-20 07:07 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

to water, will cause the liquid mixture to penetrate and allay coal dust by producing almost instant dispersion of the liquid over the dust particles.

The wetting power of the compound-water solution is based not only on the reduction of surface tension of the solution but also upon the reduction of the interfacial tension between the solid and the liquid.

ARRANGEMENT OF SPRAY NOZZLES OF VARIOUS SIZES OF ORIFICES ON CONTINUOUS-MINING MACHINE

During the tests to find means to allay the coal dust created by the continuous-mining machine, it was observed that the greatest amount of dust was released from the sides of the cutting and conveyor head of the machine when the head was operated through the arcs from horizontal to full-height position. Spray nozzles C and F were positioned similarly on opposite sides of the cutting and conveyor head on the elevating arms of the machine, and they were equally effective in delivering sprays to form curtains of medium mist on the sides of the conveyor and cutting head of the machine. However, on the upswing of the cutting and conveyor head from horizontal to full-height position, the spray from nozzle E, positioned on the right side board of the conveyor, aided the spray from nozzle C in effectively allaying of the dust created and released on the right side of the cutting and conveyor head of the machine. As no spray nozzle was positioned on the left side board of the conveyor in a similar position as spray nozzle E on the right side board of the conveyor, it was deemed necessary equip nozzle F with a larger orifice than nozzle C because of the area that was not curtained effectively with sprays when a nozzle equipped with an orifice smaller than size 6 was used at position F.

METHOD OF ADDING WETTING AGENT

One pound of wetting compound was used with about 1,000 gallons of water. A solid cartridge of the compound 4 inches in diameter and 10 inches long was placed upright in a steel receptacle, which was connected to the pipeline at the discharge end of the pump. Water from the discharge end of the pump was admitted to the bottom of the unit and passed around the sides of the cartridge, dissolving the wetting agent.

Figure 3 is a schematic sketch of the steel receptacle in which the cartridges were placed during the tests.

Figure 4 shows the complete operating assembly, except for the receptacle, of the high-pressure, triplex plunger pump of the type that was used to create pressure to force water and water mixed with compound to and through the nozzles on the continuous-mining machine during the tests.

DUST CONDITIONS DURING ORIGINAL TEST

At the beginning of a 24-hour test during three consecutive working shifts, a sheet of white paper 24 by 24 inches, which had absorbed moisture and was damp, was placed in the return-air course 30 feet outby the working face, in an upright position 10 degrees from horizontal and facing the direction of the return-air current from the working face where the machine was operating.

Generated on 2024-09-20 07:03 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

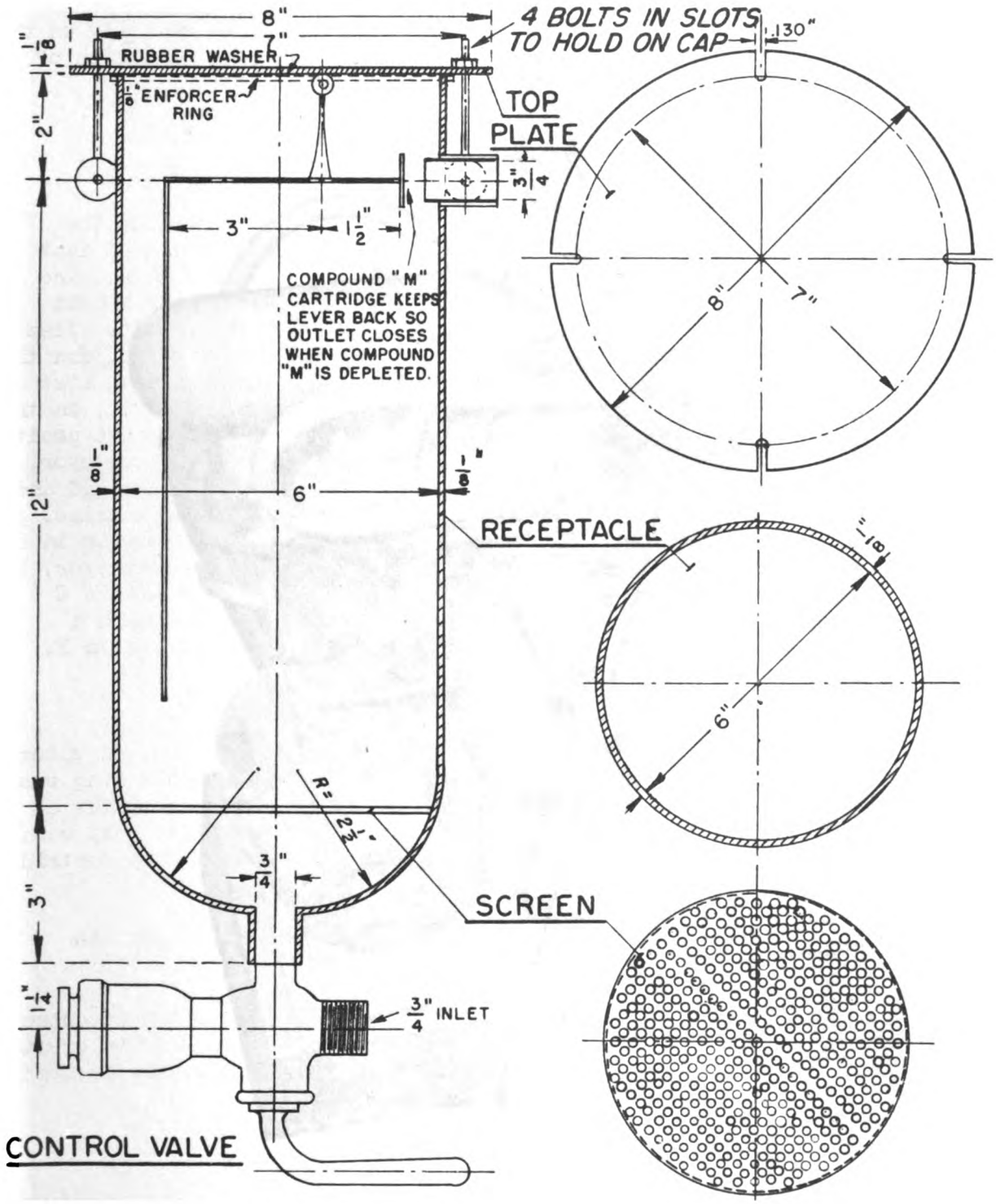

Figure 3. - Steel receptacle in which wetting-compound cartridges were placed.

Generated on 2024-09-20 07:03 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-20 07:05 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

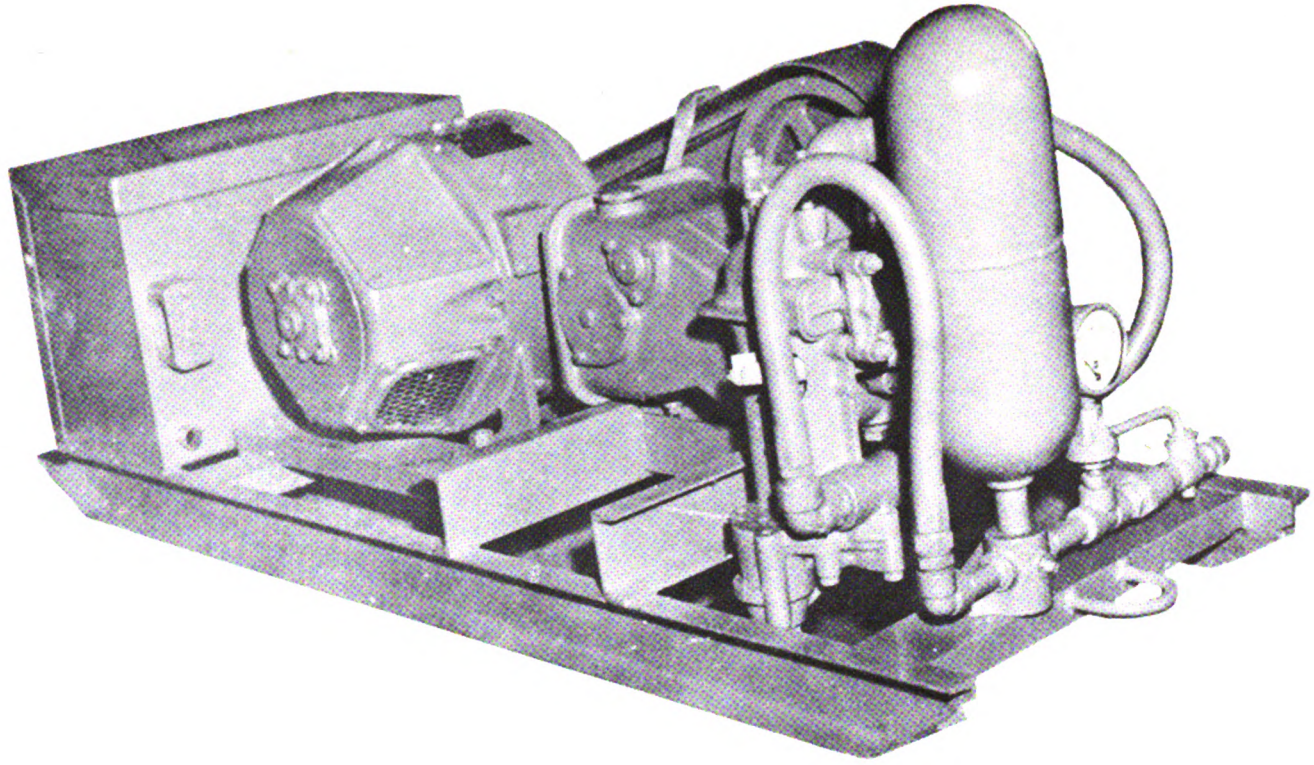

Figure 4. - Complete operating assembly of the high-pressure triplex plunger pump except for the wetting-compound receptacle.

Digitized by Google
Original from THE OHIO STATE UNIVERSITY

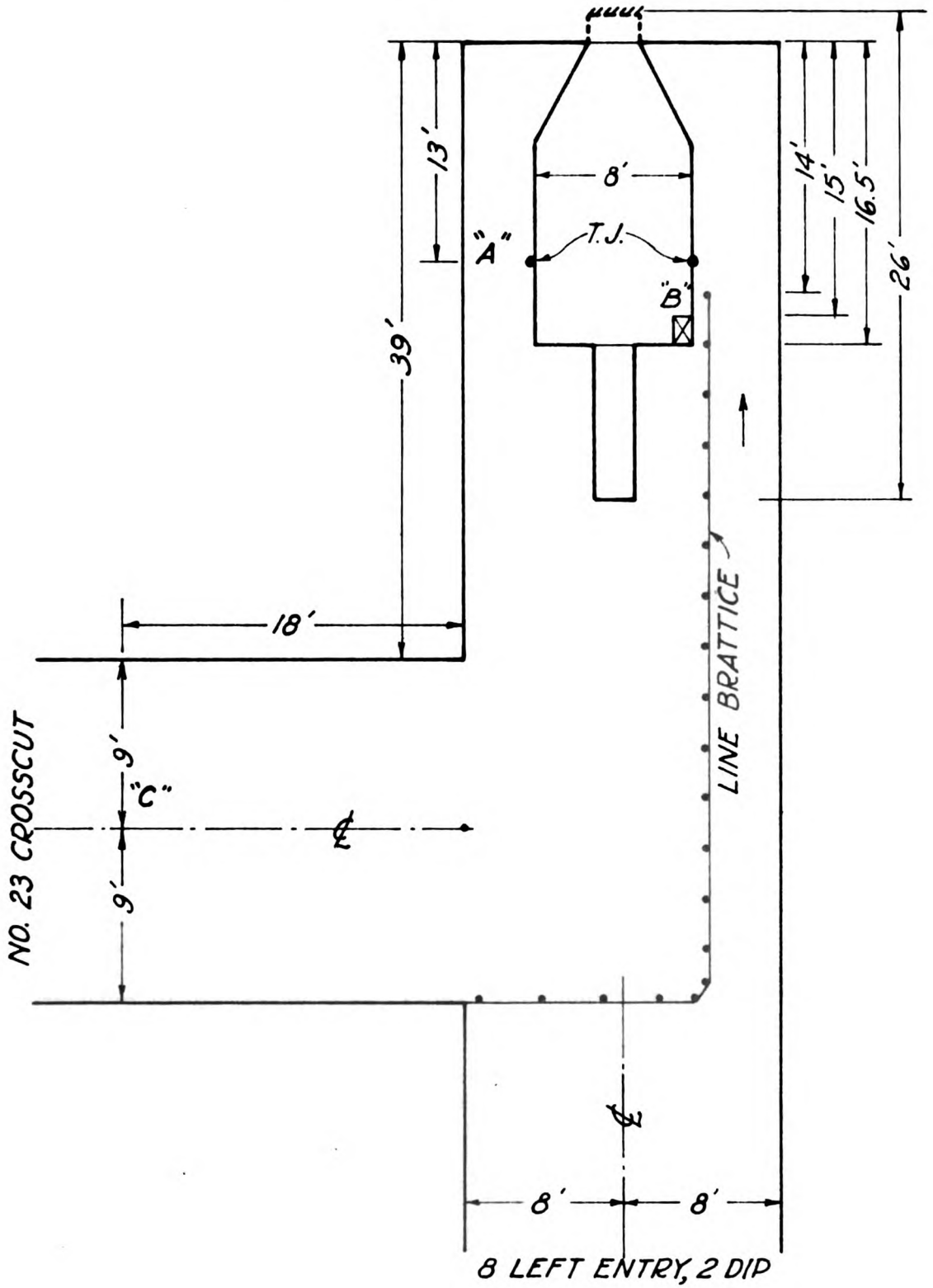

Figure 5. - Plan showing position of continuous-mining machines, arrangement of line brattice, and three places where dust samples were collected in No. 23 crosscut and 8 left entry, 2 dip, Sunnyside No. 1 mine, Kaiser Steel Corp., Sunnyside, Utah.

Generated on 2024-09-20 07:10 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

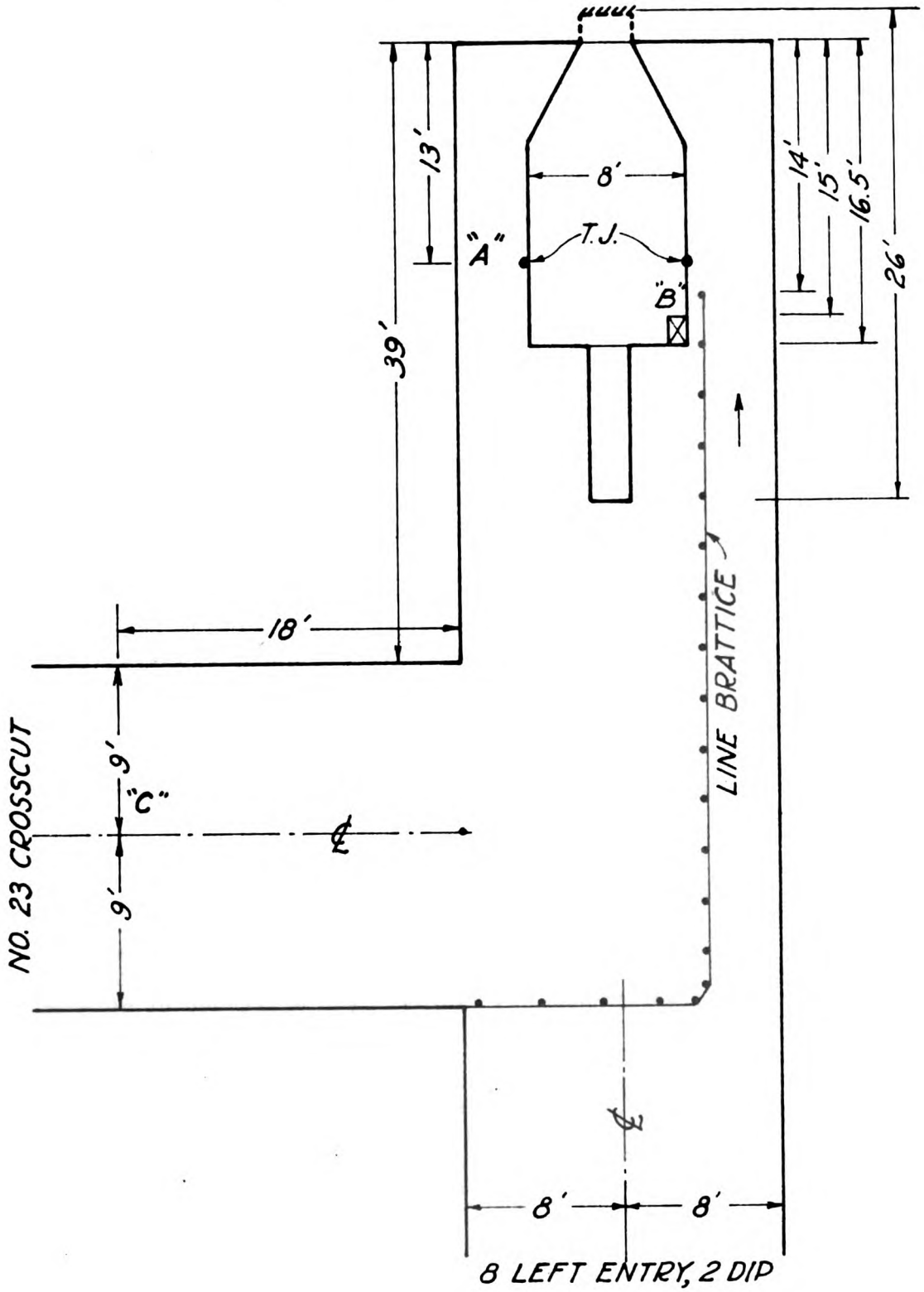

Figure 5. - Plan showing position of continuous-mining machines, arrangement of line brattice, and three places where dust samples were collected in No. 23 crosscut and 8 left entry, 2 dip, Sunnyside No. 1 mine, Kaiser Steel Corp., Sunnyside, Utah.

Generated on 2024-09-20 07:15 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

A negligible amount of coal dust was deposited on the paper during the period when water mixed with compound was used to allay the dust. Similar sheets of paper in similar condition and position were used during the trial-and-error periods of trying to perfect a method of allaying effectively the coal dust created and released during operation of the continuous-mining machine, and during some of these periods a great deal of coal dust was deposited on the paper. However, these sheets of paper were used only as a guide to determine the progress that was being made from time to time in allaying the coal dust during positioning and adjusting of spray nozzles at various angles of effectiveness.

METHOD ADOPTED IN SUNNYSIDE NO. 2 MINE

The dust-allaying method that was found to be effective in the Sunnyside No. 1 mine was adopted and used successfully also in Sunnyside No. 2 mine, Kaiser Steel Corp., Sunnyside, Utah. Installations in the two mines are virtually identical.

SURVEY OF AIR-BORNE DUST

After the original experiment and tests on the effectiveness of the arrangement of the spray nozzles on the continuous-mining machines in the Sunnyside Nos. 1 and 2 mines were conducted, a survey of air-borne dust was made in the area in which the continuous-mining machine of the Sunnyside No. 1 mine was operated. Factual information was obtained when the machine was operated with and without coal-dust-allaying facilities.

Air-borne-dust samples were collected at places "A", "B", and "C", which are indicated on figure 5. Three samples of air-borne dust were obtained while the machine was operated during each of the following arrangements: (1) without dust-allaying facilities, (2) with water alone, and (3) with a solution of water and wetting compound.

DESCRIPTION AND OPERATION OF MIDGET IMPINGER

The Bureau of Mines midget impinger dust-sampling apparatus was used to collect the air-borne coal-dust samples during operation of the continuous-mining machine in Sunnyside No. 1 mine. The underlying principle of the impinger is based on impinging and wetting dust particles by drawing the air through a nozzle at high velocity onto a smooth surface under a bubbling column of liquid, where the dust particles are retained in isopropyl alcohol. This impinger consists essentially of two parts: First, a four-cylinder pump to draw the air to be sampled through the sampling device;6/ and second, the sampling flask, which consists of a container and the impinger tube; the bottom of the flask serves as the impinger plate.

DATA RELATING TO OPERATION OF THE CONTINUOUS MINING MACHINE IN SUNNYSIDE NO. 1 MINE

A volume of 11,485 cubic feet of air a minute was circulated at the end of the line brattice, 14 feet from the face of 8 left entry, 2 dip. The

6/ Schrenk, H. H., and Feicht, Florence L., Bureau of Mines Midget Impinger: Bureau of Mines Inf. Circ. 7076, 1939.

Generated on 2024-09-20 07:04 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

velocity of the air current was 296 feet a minute, and the cross-sectional area behind the line brattice was 38 square feet (5.75 feet wide by 6.75 feet high).

The volume of air returning from the face of 8 left entry, measured in No. 23 crosscut 18 feet from the intersection of No. 23 crosscut and 8 left entry, 2 dip, was 11,480 cubic feet per minute. The velocity of the returning air current was 85 feet a minute, and the cross-sectional area of No. 23 crosscut was 135 square feet (18 feet wide by 7.5 feet high).

At the beginning of the air-borne-dust survey in 8 left entry, the machine operator, who was sitting on the right side of the machine, was about 15 feet from the face of the entry and 2 feet outby the end of the line brattice. As the machine was advanced, the end of the line brattice was extended so that the position of the machine operator was nearly always 2 feet outby the end of the line brattice. The position of the machine operator on the machine is denoted by /x/ on the plan view of the machine in figure 5.

DUSTINESS LIMITS

Tests and observations have indicated that in bituminous-coal mines 40 million particles per cubic foot constitutes a dusty atmosphere; this figure is recommended as the maximum allowable concentration.1/

Dust concentrations can be kept below 20 million particles per cubic foot in most mining operations in the bituminous-coal mines in the United States. It has been recommended, therefore, that this figure should not be exceeded, but the average exposure for any workman should not exceed 20 million particles per cubic foot of air for an entire shift, and the concentration for any one operation should not exceed 40 million particles per cubic foot.1/

DENSITY OF DUST SAMPLES

The average density of air-borne-dust samples collected while the machine was being operated without dust-allaying facilities and with dust-allaying facilities is shown in table 2.

1/ Owings, C. W., Control of Air-Borne Dust in Bituminous-Coal Mines in the United States: Bureau of Mines paper presented before the Fifth International Conference of Directors of Mine Safety Research, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa., Sept. 20-25, 1948.

Generated on 2024-09-20 07:06 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

TABLE 2. - Density of air-borne-dust samples collected during operation of the continuous-mining machine

Laboratory sample No.	Places where sample was collected	Collection time min.	Without dust-allaying facilities	Dust allay with water	Dust allayed with water and wetting compound
1	"A"	5	1,128.00	-	-
2	"B"	5	152.00	-	-
3	"C"	5	736.00	-	-
4	"A"	15	-	18.98	-
5	"B"	15	-	5.88	-
6	"C"	15	-	7.40	-
7	"A"	15	-	-	1.20
8	"B"	15	-	-	.30
9	"C"	15	-	-	1.62

NUMBER CONCENTRATION OF MINE ATMOSPHERIC DUST DETERMINED BY THE MIDGET MICROPROJECTOR METHOD

The nine air-borne coal-dust samples collected in the Sunnyside No. 1 mine during operation of the continuous-mining machine were analyzed for number concentration. To determine the amount of dust in the samples, each filled dust-counting cell[8] was placed on the stage of a midget microprojector, which is a microscope arranged to project images on a ruled translucent screen,[9][10] for bright-field counting of dust in impinger samples.[8][11] The amount of dust in each sample was determined by counting the particles in a known volume of the impinger liquid.

SIZE OF DUST PARTICLES

The size of dust particles varies greatly, but as the Bureau of Mines considers only particles of dust 10 microns or less in diameter when making dust counts,[7] the size of the dust particles counted during the air-borne-dust survey was 10 microns or less.

RATE OF DISCHARGE OF PUMP

The hydraulic pressure of the high-pressure pump was decreased from static pressure of 800 pounds per square inch at no delivery to 300 pounds per square inch while nozzles were in operation.

8/ Brown, Carlton E. and Schrenk, H. H., A Technique for Use of the Impinger Method: Bureau of Mines Inf. Circ. 7026, 1938.

9/ Brown, Carlton E. and Yant, William P., The Microprojector for Determining Particle-Size Distribution and Number Concentration of Atmospheric Dust: Bureau of Mines Rept. of Investigations 3289, 1935.

10/ Brown, Carlton E., Midget Microprojector for Dust Determinations: Bureau of Mines Rept. of Investigations 3780, 1944.

11/ Brown, C. E., Baum, L. A. H., Yant, W. P., and Schrenk, H. H., Microprojection Method for Counting Impinger Dust Samples: Bureau of Mines Rept. of Investigations 3373, 1938.

Generated on 2024-09-20 07:09 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The pump discharged approximately 12.8 gallons of water a minute at a pressure of 600 pounds per square inch. The pump is a positive displacement type that operates at fairly constant speed. As a result, the rate of discharge of the pump did not vary more than 5 percent throughout the tests; therefore, about 12.8 gallons of water a minute was forced through the one No. 4 and the six No. 6 nozzles, all of which were mounted on the machine during the time of the air-borne-dust survey. The pump assembly is shown in figure 4.

TABLE 3. - Quantity of water discharged by a pump through high-pressure spray nozzles at various pressures

Manufacturer's nozzle nos.	Diameters of nozzle orifices		Number of holes in swirl plate	Gallons per minute delivered through nozzles at various pressures, pounds per square inch					
	64ths of an inch	Decimal parts of 1 inch		100	200	300	400	500	600
			7	0.33	0.43	0.53	0.62	0.69	0.77
			4						
2-1/2	5/128	0.039062	2	.27	.35	.42	.48	.53	.58
			7	.47	.63	.76	.88	.97	1.04
			4	.41	.55	.67	.80	.91	
3	3/64	.046875	2	.35	.45	.53	.61	.68	.75
			7	.85	1.15	1.38	1.58	1.79	1.98
			4	.63	.86	1.07	1.27	1.44	
4	4/64	.062500	2	.51	.65	.77	.88	.99	1.09
			7	1.30	1.78	2.15	2.45	2.72	2.96
			4	.77	1.07	1.33	1.59	1.81	
5	5/64	.078125	2	.71	.88	1.03	1.17	1.30	1.42
			7	1.75	2.43	2.95	3.40	3.78	4.15
6	6/64	.093750							

TYPE AND DIMENSIONAL POSITION OF SPRAY NOZZLES INSTALLED ON CONTINUOUS MINING MACHINE

The nozzles used on the continuous-mining machines in the Sunnyside Nos. 1 and 2 mines were high-pressure spray nozzles with carbide inserts.

The spray nozzles affixed to the continuous-mining machine contained swirl plates with seven holes. The apex spray angles formed by the spray nozzles containing seven plates were as follows: No. 2 spray nozzle formed an apex spray angle of 12.5 degrees; No. 3, 15 degrees; No. 4, 20 degrees; No. 5, 26 degrees; and No. 6, 31 degrees.

The design of the high-pressure spray nozzle is shown in figure 6, and the complete assembly of two of the high-pressure spray nozzles is shown in figure 7.

Figure 8 is a sectional drawing of an atomizer spray nozzle of the type used effectively for dust-allaying purposes in Australian coal mines.

Generated on 2024-09-20 07:06 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

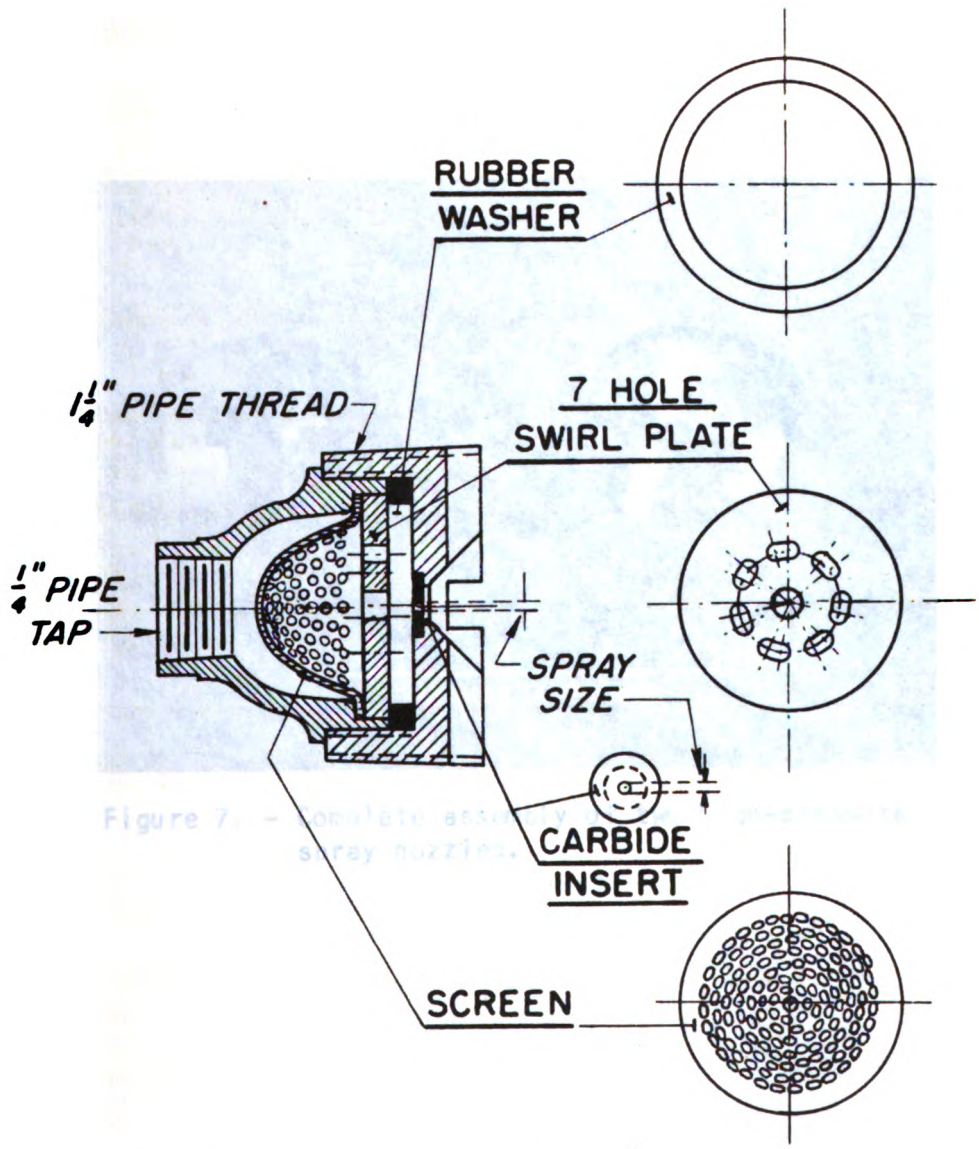

Figure 6. - Side and end sectional view of high-pressure spray nozzle.

Generated on 2024-09-20 07:03 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
THE OHIO STATE UNIVERSITY

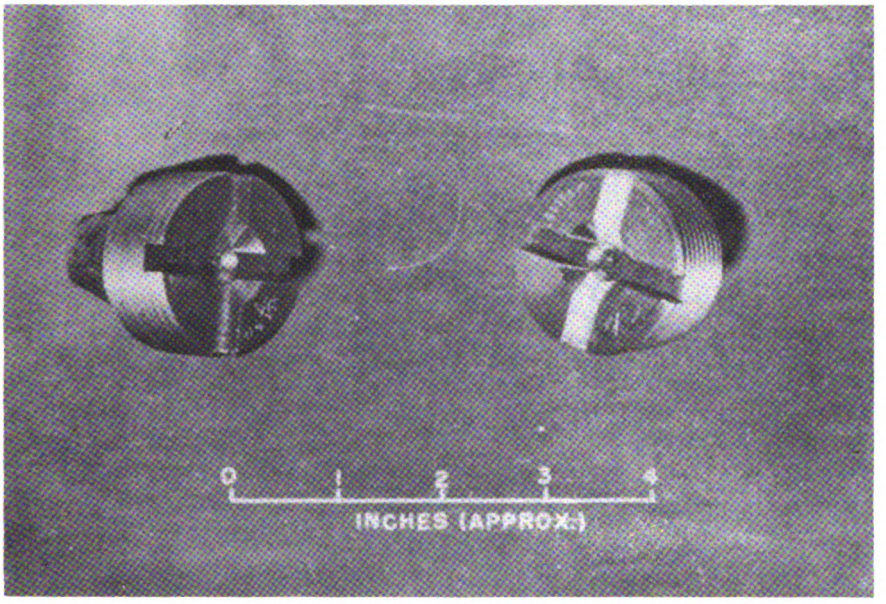

Figure 7. - Complete assembly of two high-pressure spray nozzles.

Generated on 2024-09-20 07:04 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

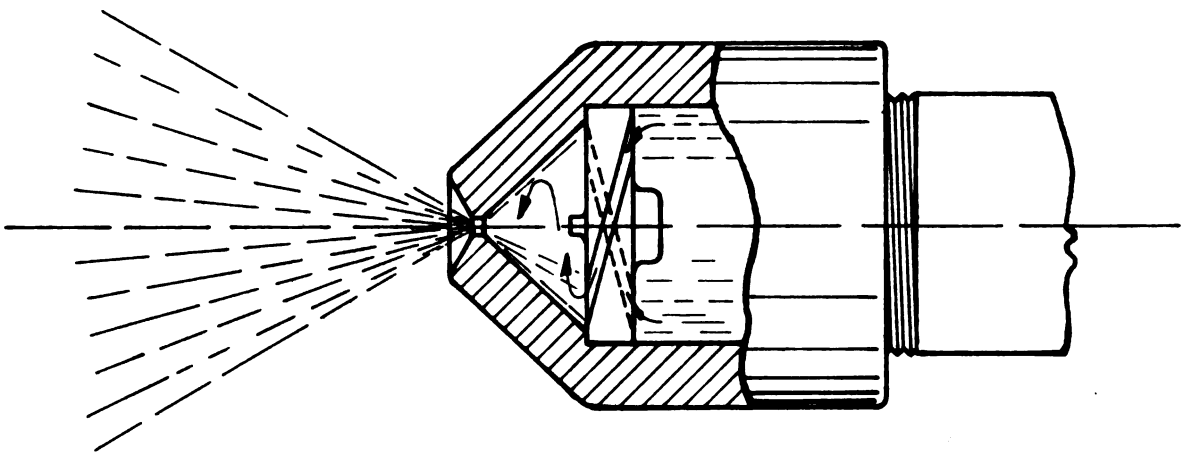

Figure 8. - Sectional drawing of atomizer spray nozzle.

Generated on 2024-09-20 07:28 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

The cutting and conveyor head of the continuous-mining machine in Sunnyside No. 1 mine was equipped with six cutting chains, which were abutted together, side by side, in vertical or shearing position; each chain had a total of 28 tungsten-carbide insert bits. Each cutter chain on the continuous-mining machine in the Sunnyside No. 2 mine had a total of 36 tungsten-carbide insert bits. The cutting chains were revolved upward and over the top of the cutter bar from its head end.

Spray nozzles A and B, as indicated in figure 1, were laid in a horizontal plane above the tops of the cutting chains and were mounted 6-1/2 inches above the tips of the bits and 78 inches back of the head end of the cutter bar. The centers of the two sprays intersected the center line of the six-chain cutter bar at the tips of the bits, 6 inches back of the head end of the cutter bar; thus, the spray nozzles were angled 10° 24' from the vertical planes of the cutter-bar frames. When the continuous-mining machine was sumped in, the water sprays struck the loose coal on the cutter bar and the coal in place above the cutter bar about 60 inches ahead of the spray nozzles, or 18 inches back of the tips of the cutting bits at the head end of the cutter bar.

Spray nozzles C and F (F is on the opposite side of the machine in a position corresponding to C, in figure 1) were mounted horizontally 44 inches back of the head end of the cutter bar and 3-1/2 inches outside the cutter-bar frames, and the centers of the sprays were 9-3/4 inches below the tips of the top-positioned cutting bits.

Spray nozzles D and G (G is on the opposite side of the machine in a position corresponding to D, shown in figure 1) were mounted separately on the two elevating jack arms of the cutter bar, each in a position 3 inches below the bottom-positioned channels of the outside of the cutter bar and 44 inches back of the head end of the cutter bar. The spray nozzles were angled downward 11° 40'; the centers of the sprays were 17 inches below the horizontal center line of the head shaft of the cutter bar.

Spray nozzle E, as indicated in figure 1, was mounted horizontally inside the right frame of the flight-chain conveyor, 3 inches below the top edge of the frame and 50 inches back of the horizontal center line of the sprocket shaft of cutter bar. The spray nozzle was angled horizontally 10° 12' 14" toward the center line of the flight-chain conveyor, intersecting the center line of the flight-chain conveyor at the sprocket shaft 50 inches ahead of the mounted spray nozzle.

NOZZLES

Before the air-borne dust survey was made, the spray nozzle on the continuous mining machine in the Sunnyside No. 1 mine had been replaced with No. 6 spray nozzles, with the exception of the No. 4 spray nozzle mounted on the machine at the designated position shown in figure 1.

Spray nozzles of different sizes were used during the tests. During the air-borne dust survey, all nozzles used on the continuous-mining machine in the Sunnyside No. 1 mine were of manufacturer's size 6, except for the nozzle of No. 4 size used on the machine at position E (see fig. 1). The spray nozzles of No. 6 size formed spray angles of 31 degrees, whereas spray nozzles of smaller manufacturer's rated sizes formed spray angles less than 31 degrees.

Generated on 2024-09-20 07:05 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Because of the relative nearness to the working face of the spray nozzles positioned at A, B, C, D, F, and G on the machine, it was considered, through observation, that better results would be obtained if spray nozzles forming larger spray angles were near the working face so as to entrap the dust created and released at the working face. However, the spray nozzle positioned at E on the machine was size No. 4 and formed a spray angle of 20 degrees, which was considered large enough to entrap any dust that could escape entrapment by the other sprays near the cutting and conveyor head of the machine and could travel from the floor conveyor opening to the opening of the main conveyor of the machine. Sprays of water and water mixed with wetting compound from nozzles that formed smaller spray angles were released with apparently greater striking force than those from the larger spray nozzles; so, in selecting the position on the machine of the sprays of various sizes, it was necessary to consider primarily the functions of the sprays released by the various nozzles in respect to area covered or curtained and striking force. Therefore, the two important functions of the sprays had to be contrasted in order to obtain desired results. The observed results of the last arrangement of nozzles according to size were slightly better than those of the first arrangement.

Generated on 2024-09-20 07:28 GMT / https://hdl.handle.net/2027/osu.32435030643696
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY